



Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial Climate of 2008

Natural Resource Data Series NPS/ERMN/NRDS—2010/XXX



ON THE COVER

Photo description. Summer sky at Allegheny Portage Railroad National Historic Site 2009

Photograph by: Kathy Penrod

Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial Climate of 2008

Natural Resource Data Series NPS/ERMN/NRDS—2010/XXX

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All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner. This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

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Table of Contents

	Page
Table of Contents.....	iii
Figures.....	v
Tables.....	v
List of Key Acronyms.....	vi
Executive Summary.....	1
Introduction.....	3
The Climate of the of the South Central Mountains.....	5
Calendar Year 2008 Temperature Summary.....	11
Growing Degree Days.....	18
Calendar Year 2008 Precipitation Summary.....	151
Stream Flow for 2008.....	206
Drought Status.....	228
References.....	325
Appendix.....	34

Figures

	Page
Figure 1. Location of observing sites around the Johnstown Flood National Memorial and Allegheny Portage Railroad National Historic Site.	5
Figure 2. Map showing departures from average maximum daily temperatures (°F/°C) for each month in the calendar year 2008.....	8
Figure 3. Map showing departures average minimum daily temperatures (°F/°C) for each month in the calendar year 2008.....	9
Figure 4. Annual soil temperature trends for ALPO-JOFL as seen from the North American Regional Reanalysis data set..	12
Figure 5. The accumulation of growing degree days for the ALPO/JOFL cooperative reporting stations based on a 90 day period from January 1 to April 1 each year.....	17
Figure 6. The accumulation of growing degree days for the ALPO/JOFL cooperative reporting stations based on a 150 day period from January 1 to June 1 each year.....	18
Figure 7. The accumulation of growing degree days for the ALPO/JOFL cooperative reporting stations based on the majority of the growing season (215 days).....	18
Figure 8. Maps showing percent of average precipitation for each month in the calendar year 2008.....	21
Figure 9. Annual soil moisture trends for ALPO/JOFL as seen from the North American Regional Reanalysis data set..	19
Figure 10: The Conemaugh River flows near the Johnstown Flood National Memorial. Below normal discharge can be seen beginning in June and extending into the autumn.	20
Figure 11. The flow of the Conemaugh River near the Johnstown Flood National Memorial. The effects of a wet winter and then a dry summer are notable.	21
Figure 12. A comparison of the Palmer Drought Severity Index (PDSI) for the Pennsylvania Climate Division 8, which encompasses most of ALPO and JOFL.....	22
Figure 13. The mid-month values of the PDSI for Pennsylvania showing that dry conditions rarely encroached on the Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial region.	23
Figure 14. The mid-month values of the PDSI for the Northeast during the 2008 warm season. Southern New Jersey was the most consistently dry region.....	24

Tables

	Page
Table 1. Summary of 2008 significant climate indicators for the Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial.	1
Table 2. List of four weather/climate reporting sites around Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial.....	6
Table 3. Summary of 2008 departure from normal temperature based on 30-year normal (1971–2000) for reporting sites around Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial.	10
Table 4. Summary of monthly average temperatures for 2008 for reporting sites around Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial....	10
Table 5. Using aggregated data from more than a dozen COOP stations in proximity (within 100 km of the parks) known as PA Climate Division 8, the values indicate a wet winter followed by an average, relatively wet spring, a dry and cool summer and a cool, moist autumn.	10
Table 6. Temperature indicators of the climate near ALPO-JOFL parks using a COOP site at Ebensburg and a FAA site at Johnstown and comparing their 2008 data with a long-standing site at Pittsburgh, Pennsylvania..	11
Table 7. Summary of 2008 monthly total precipitation (in/mm) for reporting sites around Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial... ..	18
Table 8. Summary of 2008 percent of normal precipitation based on 30-year normal (1971–2000) for reporting sites around Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial.	18
Table 9. A comparison of wettest single calendar days during 2008 with the longest periods with a trace or less of rainfall during the same year in Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial.	18
Table 10. Precipitation indicators of the climate in the Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial parks using a COOP site at Ebensburg and a FAA site at Johnstown and comparing their 2008 data with a long-standing site at Pittsburgh, Pennsylvania.	19

List of Key Acronyms

ALPO	Allegheny Portage Railroad National Historic Site
COOP	National Weather Service Cooperative Observer Program
CWOP	Citizen Weather Observer Program
FAA	Federal Aviation Administration
IFLOWS	Integrated Flood Observing and Warning System
JOFL	Johnstown Flood National Memorial
NADP	National Atmospheric Deposition Program
NARR	North American Regional Reanalysis
NCDC	National Climatic Data Center
NWS	National Weather Service
PDSI	Palmer Drought Severity Index
PRISM	Parameter-elevation Regressions on Independent Slopes Model
RAWS	Remote Automated Weather Stations
USGS	United States Geological Survey

Executive Summary

Weather and Climate for Calendar Year 2008

The year began with a stretch of mild weather in January when daytime maximums reached into the 60's°F (15.6°C to 20.6°C) for three consecutive days (7th-9th) which was 25°F (13.9°C) above normal. A cool down in February and March lead winter temperatures to be near normal. Despite May temperatures being ~1.7°F (0.9°C) below average, the spring also averaged near normal. The second half of 2008 featured cooler than average temperatures with 4 of the 6 months recording negative monthly temperature departures. Precipitation varied significantly throughout the year. The mid-month values of the Palmer Drought Severity Index showed that the drought conditions rarely encroached on the Allegheny Portage Railroad NHS and the Johnstown Flood NMem. Despite this, January was fairly dry with only 50-77% of normal precipitation. February and May on the other hand had above average precipitation. Dry spells were most common in the late summer and early fall with no rain falling for 11 consecutive days in August. The effects of a wet winter followed by a dry summer were shown in the flow pattern of the Conemaugh River near the Johnstown Flood NMem. The final month of the year was very wet with over 200% of normal precipitation in the region. With the excessive rainfall in December, the year overall was slightly above average with regard to precipitation.

Climate Indicator Status and Trends

Temperatures in 2008 were lower than the 30 year normal (Table 1) and was the chilliest year since 2003. This was reflected by the minimum temperature dipping below 32°F (0°C) on 134-147 occasions which is well above the average of 124. In addition, maximum temperatures never rose above 90°F (32°C) which is slightly below average. This cooler regime led to a growing season of 137-159 days, which is below the long-term average. Precipitation as a whole was near average while more snowfall was observed above the normal. The key factor with precipitation in 2008 was the excessively wet December when more precipitation fell than October and November combined. The largest outbreaks of severe weather occurred on June 22nd when 1 inch (25 mm) hail was reported in Nanty-Glo, PA and on July 20th when severe storms downed trees and power lines. The lowest temperature recorded in 2008 was -5°F (-20.6°C) on February 21st while the highest maximum temperature occurred on June 10th with a reading of 88°F (31.1°C).

Table 1. Summary of 2008 climate indicators for the Allegheny Portage Railroad NHS and Johnstown Flood NMem. Data from the COOP weather station at Ebensburg, PA (EBNP1) and FAA station at Johnstown, PA (KJST) compared to the 30-year means from Pittsburgh, PA (KPIT).

Metric	2008 Statistics	Comments on Trends
Average Annual Maximum Temperature	55.4-58.6°F (13.0- 14.8°C)	Below the 30-year mean of 60°F (15.6°C)
Average Annual Minimum Temperature	36.7-39.9°F (2.6-4.4°C)	Below the 30-year mean of 40°F (4.4°C)
Hot Days (number of days Tmax>90°F/32°C)	0 days	Below the 30-year mean of 3 days
Cold Days (number of days Tmax<32°F/0°C)	41-50 days	Above the 30-year mean of 37 days
Winter Minimums (Lowest Temp)	~-5°F/-20.6°C	Above the long-term record of -22°F (-30°C)
Sub-freezing Nights (number of days Tmin<32°F/0°C)	134-147	Above the long term average of 123.9
Cold Winter Nights (number of days Tmin <0°F/-17.8°C)	2-5	Near the long term mean of 3.5
Growing Season:		
Days between last spring 32°F/0°C and first fall 32°F/0°C	137-159 days	Below the 30-year mean of 160-180 days
Annual Precipitation	43.6-49.5 in. (1107-1257 mm)	Above the long-term average of 37.9 in (963 mm)
Autumn (Oct, Nov, Dec) Precipitation	9.8-13.5 in (249-343 mm)	Near the long-term average of 10-11 in (254-279 mm)
Number of days ≥ 1.0 in (25 mm) rain	5-7	Near the 30-year mean of 6 days
Micro-drought (number of strings of 7+ days without rain)	3-4	Near the long-term mean of 4
Annual Snowfall	74-87 in (188-221 cm)	Above the 30-year mean of 60-70 in (152-178 cm)

Introduction

Weather and climate are widely recognized as key drivers of terrestrial and aquatic ecosystems, affecting biotic as well as abiotic ecosystem characteristics and processes. Global and regional scale climatic patterns, trends, and variations are critical to the cycling of elements, nutrients, and minerals through the ecosystems and can deliver pollutants from regional and even global sources (National Assessment Synthesis Team, 2001). These variations and trends influence the fundamental properties of ecologic systems such as soil-water relationships and plant-soil processes and their disturbance rates and intensity. Information obtained from meteorological monitoring will be useful to interpreting and understanding changes in species composition, community structure, water and soil chemistry, and related landscape processes (Marshall and Piekielek, 2007).

The purpose of this report is to provide a concise climate summary for January 1 to December 31, 2008, and to place current patterns and trends in an appropriate historical, regional, and global context (Knight et al, in preparation). It is our intention that this report will satisfy an inherent interest in meteorological phenomena, and meet the Eastern Rivers and Mountains Network (ERMN) Weather and Climate Monitoring objectives:

- Document long-term trends in weather and climate through seasonal and annual summaries of selected parameters (e.g., multiple forms of precipitation, temperature).
- Identify and document extremes and averages of climatic conditions for common parameters (e.g., precipitation, air temperature), and other parameters where sufficient data are available (e.g., wind speed and direction, solar radiation).
- Provide information on near real-time weather parameters, historical climate patterns, and climate station metadata from a single, easy to use Internet portal.

To accomplish these objectives, a variety of atmospheric data streams were evaluated for their quality, longevity, and applicability to the ERMN parks. Since no single network contains all the pertinent measures of atmospheric phenomena to assess ecosystem health, an objective analysis of the data networks was developed and outlined in the Weather and Climate Monitoring Protocol for the Eastern Rivers and Mountains and Mid-Atlantic Networks of the National Park Service (Knight et al, in preparation). Through this analysis, a select number of weather/climate stations were chosen as representative of each park and these are the primary data sources used in the profile of last year's climate summary and trends.

In addition to a suite of summary tables, graphs, and narratives, we specifically identify a series of key climatological indicators to report status and trends on an annual basis and periodically in separate and more thorough reports. These key indicators are further described in the protocol (Knight et al, in preparation) and summarized in the body of the text.

The Climate of the of the South Central Mountains

Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial are located in Pennsylvania Climate Division 8, also known as the South Central Mountains. The South Central Mountain region is generally considered to have a humid continental type of climate, but the elevated terrain and rolling mountains keep temperatures lower than surrounding areas. The prevailing westerly winds carry most of the weather disturbances that affect the region from the interior of the continent, with the Atlantic Ocean having only an occasional influence on the climate of the area (Gawtry and Stenger, 2007). Coastal storms do, at times, affect the day-to-day weather, especially in the winter, though the air circulating southeastward from the Great Lakes dominates in the winter. Seldom do storms of tropical origin have an effect in this part of Pennsylvania, but the rough terrain has led to memorable severe floods in the warm half of the year (Gelber, 2004).

Temperatures are moderately continental with the tempering effects of the Great Lakes contributing to cloud production in the winter and mountain-valley circulation induced clouds reducing the heat during the summer. The lowest readings in the winter occur with polar air masses of Canadian origin settling over the Northeast after a fresh snowfall. The highest readings of the summer happen when the sub-tropical fair weather system, the Bermuda high, pushes westward into the Carolinas. Its clockwise circulation will direct hot, humid air from the Gulf region into the Laurel Highlands. Allegheny Portage Railroad National Historic Site tends to have greater daytime temperatures than Johnstown Flood National Memorial. However, Johnstown Flood National Memorial tends to have less sub freezing nights than the Allegheny Portage Railroad National Historic Site. The last freeze typically occurs in May and the first frosts appear in late September or October.

Precipitation is fairly evenly distributed throughout the year. Annual amounts generally range between 36 to 54 inches (914 to 1371 mm), while the majority of places receive 40 to 46 inches (1016 to 1168 mm). Greatest amounts usually occur in the spring and summer months, while February is the driest month, having about 2 inches (51 mm) less than the wettest months. Precipitation tends to be somewhat greater in the higher terrain due to uplift and additional moisture from the Great Lakes. Base upon long term averages, annual precipitation amounts tend to be greater at Allegheny Portage Railroad National Historic Site than Johnstown Flood National Memorial.

Surface winds blow from the west and northwest in the cold season and from the southwest during the warm half of the year. Thunderstorms follow a frequency that matches the solar cycle between the equinoxes and reaching a peak near the solstice. Hail is relatively infrequent, but flash floods and damaging thunderstorm winds affect parts of the region each summer. On average, tornadoes pass through the area about once every two years. Ice storms, which can cause significant disruption occur at irregular intervals, but are primarily confined to the months between December and March (Kocin and Uccellini, 2004).

Observing Sites

A total of 7 weather observing sites comprised of 6 data networks were selected around ALPO and JOFL (Figure 1). Representative stations within a 100 km range of each park were chosen based on several criteria which include proximity to the park, the representativeness of the station to the park elevation profile, the type and frequency of observations, the period of record of the data, and data availability (Knight et al, in preparation). A subset of these observing networks (IFLOWS, GOES, and NADP; 3 total observing sites) are not yet utilized for these reports due to limited data availability and/or lack of data quality assurance (Bureau of Land Management, 1997). Moreover, the percentage of time an observing station reports a particular parameters (e.g., temperature) can influence data inclusion. A total of 4 observing sites were ultimately used for this 2008 report (Table 2).

In addition to the summary information available in this report, a near real-time data stream has been made available to the ERMN through a web interface for the selected observing stations along with monthly, seasonal and annual summaries. The web interface is accessible through the following link:

http://climate.met.psu.edu/gmaps/NPS_DEVELOPMENT/interface.php

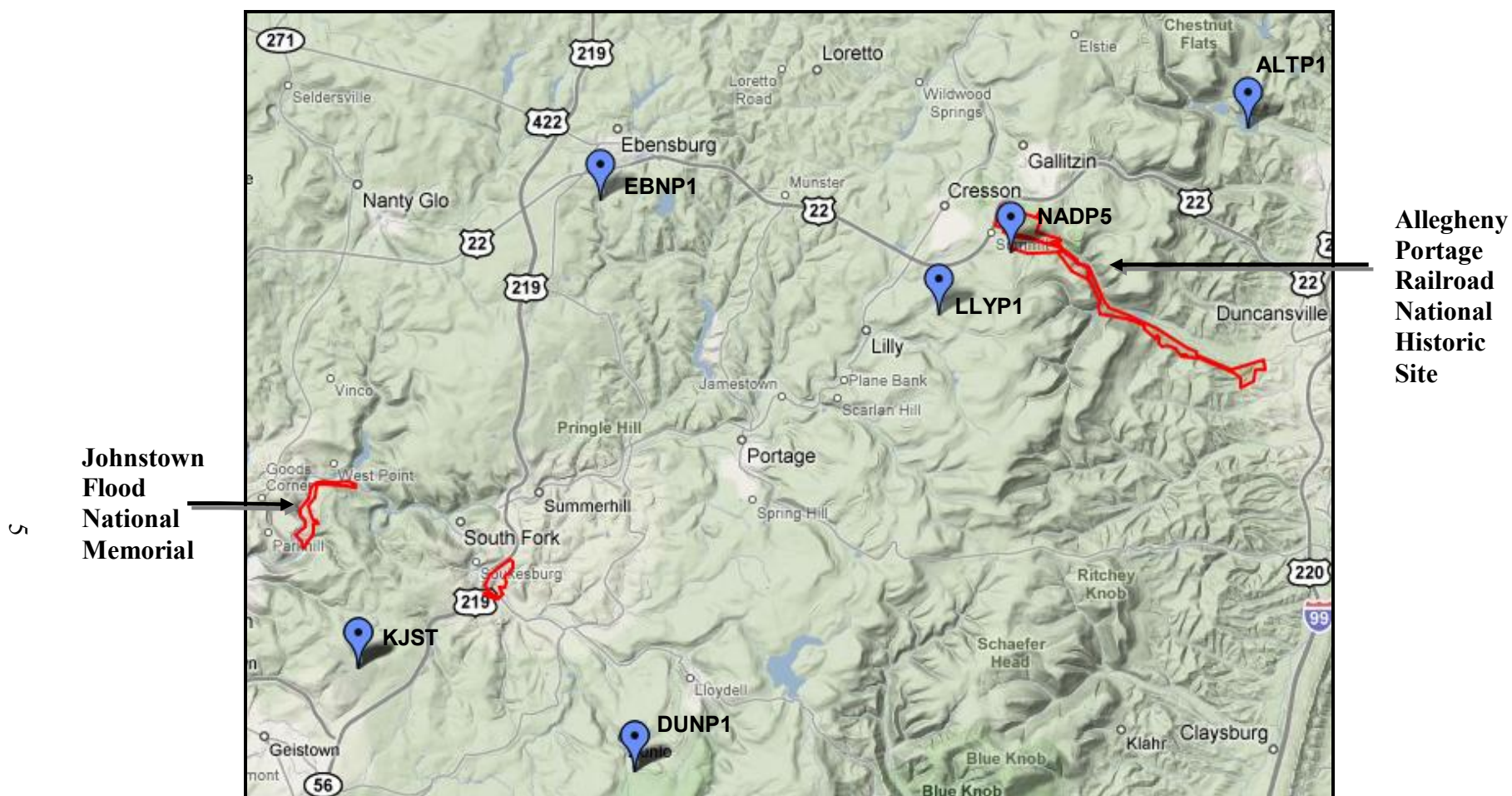


Figure 1. Location of observing sites around the Johnstown Flood National Memorial and Allegheny Portage Railroad National Historic Site. The CASTNET site located at Laurel Hill is not shown.

Table 2. List of four weather/climate reporting sites around Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial. These sites have been selected as best representative of the parks in 2008, in large part due to the percent time of reporting during 2008.

Stations	Network	Name	Period of Record (POR)		Percentage of Time Reporting Temperature for 2008	Percentage of Time Reporting Precipitation for 2008	Percentage of Time Reporting Temperature for entire POR	Percentage of Time Reporting Precipitation for entire POR
KJST	FAA	Johnstown	01/01/1973	Present	100.0	100.0	99.7	99.8
DUNP1	COOP	Dunlo	05/01/1948	Present	-	100.0	-	32.9
EBNP1	COOP	Ebensburg Sewage Plant	02/01/1964	Present	100.0	100.0	98.5	98.7
LRL117	CASTNET	Laurel Hill	01/01/1988	Present	100.0	100.0	100.0	100.0

Calendar Year 2008 Temperature Summary

Large temperature variations were common in 2008 at Johnstown Flood National Memorial and Allegheny Portage Railroad National Historic Site. In the end, the year finished slightly cooler than average.

The year began with a warmer than normal January (Figures 2 and 3). The first month was more than 2°F (1.1°C) above average for Johnstown, PA (Table 3). This positive anomaly was aided by a record high temperature of 66°F (18.9°C) on the 8th and 9th which was 30°F (16.7°C) above average. Temperatures in February were slightly cooler than normal with nighttime lows dipping below 0°F (-17.8°C) on three occasions. The lowest temperature recorded was -5°F (-20.1°C) on the 21st. Negative temperature anomalies persisted into March which was the 37th coolest in the South Central Mountain Climate Division of Pennsylvania since records began in 1895.

Spring began with above normal temperatures in April. The average temperature in Ebensburg, PA during the month was 50.9°F (10.5°C) which was 3.7°F (2°C) above average (Tables 3 and 4). Cool anomalies returned in May which was the 6th coldest May on record with an average temperature about 5°F (2.8°C) below normal. The last 32°F (0°C) reading of the spring occurred on May 23rd. Very warm weather returned in the beginning of June when 9 consecutive days (5th-13th) saw high temperatures above 80°F (26.7°C). In its entirety, temperatures in the spring were nearly average (Table 5).

Temperature anomalies in the summer varied. Warmer than normal readings occurred in July, while August readings were slightly below average. The average temperature in August was 65.4°F (18.6°C) in Ebensburg, PA which was 1.7°F (0.9°C) below average (Tables 3 and 4). Above average temperatures returned in September with a +1.0°F (0.6°C) temperature anomaly. Overall, the summer was the 31st coolest on record (Table 5). The highest temperature of the year occurred on June 10th in Ebensburg, PA with a reading of 88.0°F (31.1°C).

The cooling trend continued into the first two months of fall. The first 32°F (0°C) reading occurred on October 7th which is similar to previous years. More cool weather occurred in November despite a daytime record high temperature of 71°F (21.7°C) on the 7th. Near average temperatures occurred in December which was 0.5°F (0.3°C) below normal in Johnstown, PA (Table 3). It is interesting to note that the nighttime low on December 22nd was 0°F (-17.8°C) and just 6 days later, the daytime high was 66°F (18.9°C). Interestingly, 2008 featured a notable increase in the frequency of sub-freezing nights (Table 6). Overall, the year of 2008 was the 37th coolest and the chilliest since 2003. Though there has been a drop in surface temperatures in 2008, the 30 year trend for soil temperatures is still on the rise, which is consistent with the overall warming trend noted in the atmosphere during the past 30 years (Figure 4). The total growing season length (days between last spring freeze and first fall freeze) ranged from 137-159 days in 2008.

Allegheny Portage Railroad NHS and Johnstown Flood NM
Departure from Average Monthly Maximum Temperature
2008 vs. 1971–2000

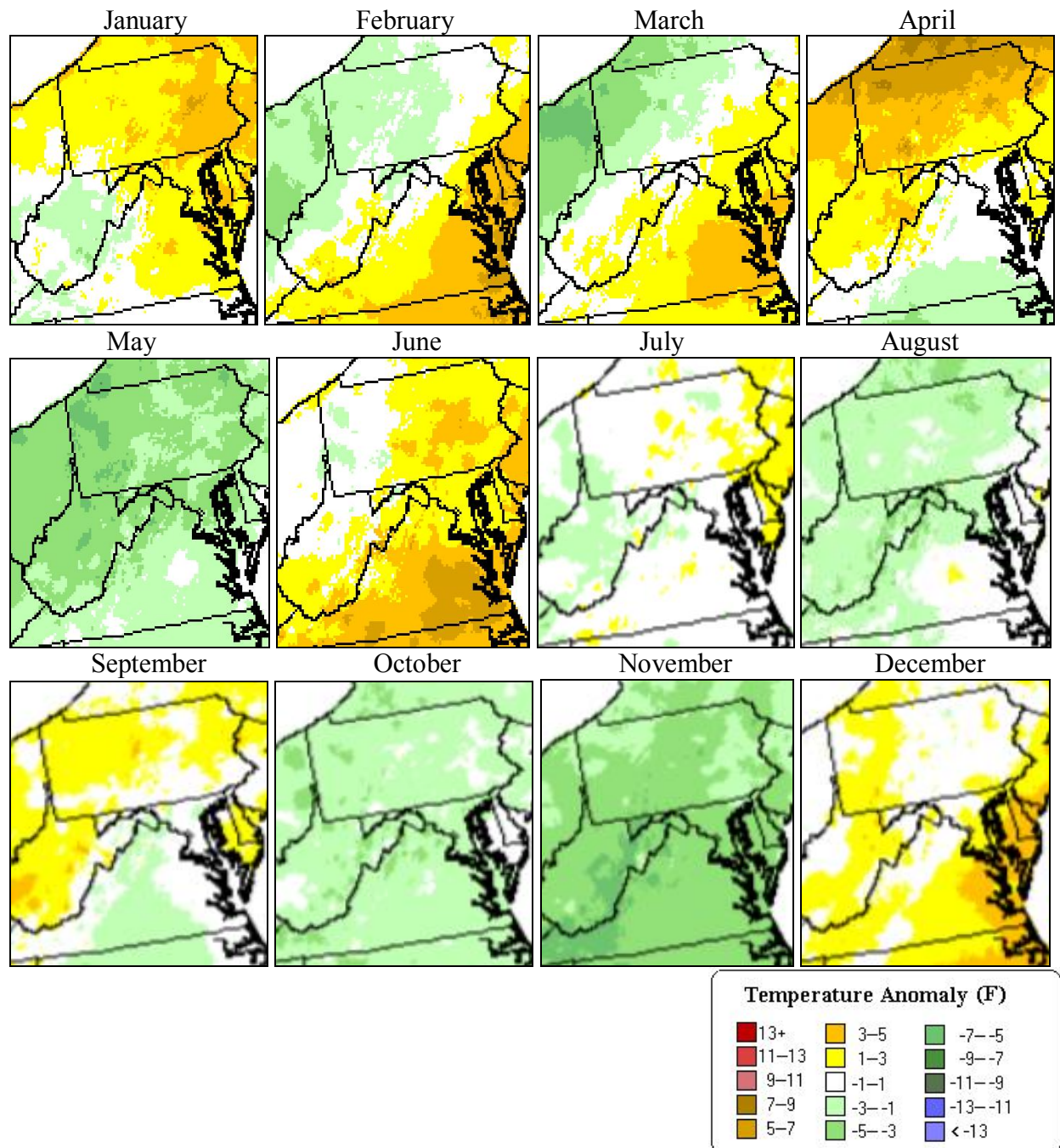


Figure 2. Map showing departures from average maximum daily temperatures ($^{\circ}\text{F}$) for each month in the calendar year 2008 as compared with the normal based on the period 1971–2000. Maps were created using estimates from the Parameter-elevation Regressions on Independent Slopes Model (PRISM). PRISM uses an interpolation scheme for temperature between actual observations and corrects these estimates for changes in topography across the region (Daly et al, 2002). More information can be found at <http://www.prism.oregonstate.edu/>.

Allegheny Portage Railroad NHS and Johnstown Flood NM
 Departure from Average Monthly Minimum Temperature
 2008 vs. 1971–2000

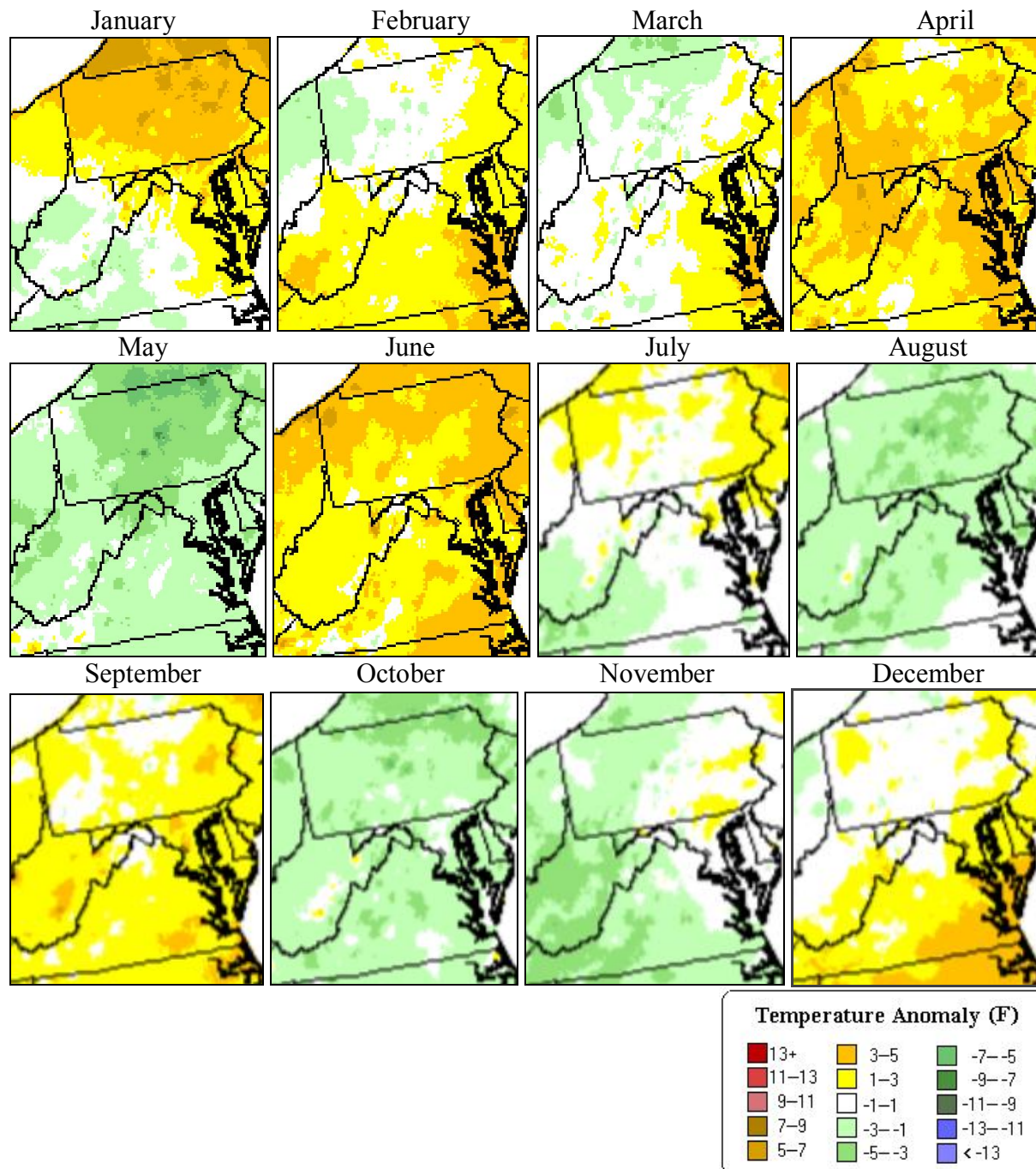


Figure 3. Map showing departures average minimum daily temperatures (°F) for each month in the calendar year 2008 as compared with the normal based on the period 1971–2000. Maps were created using estimates from the Parameter-elevation Regressions on Independent Slopes Model (PRISM). PRISM uses an interpolation scheme for temperature between actual observations and corrects these estimates for changes in topography across the region (Daly et al, 2002). More information can be found at <http://www.prism.oregonstate.edu/>.

Table 3. Summary of 2008 departure from normal temperature based on 30-year normal (1971–2000) for reporting sites around Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial.

Station Location	ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Johnstown, PA	KJST	2.81 °F	-1.33 °F	-2.41 °F	2.88 °F	-3.04 °F	1.93 °F	0.56 °F	-1.81 °F	1.31 °F	-2.04 °F	-3.13 °F	-0.49 °F
		1.57 °C	-0.74 °C	-1.34 °C	1.60 °C	-1.69 °C	1.08 °C	0.31 °C	-1.01 °C	0.73 °C	-1.13 °C	-1.74 °C	-0.27 °C
Ebensburg, PA	EBNP1	2.00 °F	-2.28 °F	-1.76 °F	3.73 °F	-3.08 °F	2.10 °F	0.44 °F	-1.65 °F	1.00 °F	-1.71 °F	-1.98 °F	0.75 °F
		1.11 °C	-1.27 °C	-0.98 °C	2.07 °C	-1.71 °C	1.17 °C	0.24 °C	-0.91 °C	0.56 °C	-0.95 °C	-1.10 °C	0.42 °C

Table 4. Summary of monthly average temperatures for 2008 for reporting sites around Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial.

Station Location	ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Johnstown, PA	KJST	28.1 °F	26.5 °F	34.6 °F	50.0 °F	53.7 °F	66.5 °F	69.0 °F	65.3 °F	61.9 °F	47.6 °F	36.4 °F	29.3 °F	47.4 °F
		-2.2 °C	-3.1 °C	1.4 °C	10.0 °C	12.1 °C	19.2 °C	20.6 °C	18.5 °C	16.6 °C	8.7 °C	2.5 °C	-1.5 °C	8.6 °C
Ebensburg, PA	EBNP1	27.3 °F	25.5 °F	35.2 °F	50.9 °F	53.7 °F	66.7 °F	68.9 °F	65.42 °F	61.6 °F	47.9 °F	37.6 °F	30.5 °F	47.6 °F
		-2.6 °C	-3.6 °C	1.8 °C	10.5 °C	12.1 °C	19.3 °C	20.5 °C	18.6 °C	16.4 °C	8.9 °C	3.1 °C	-0.8 °C	8.7 °C
Laurel Hill, PA	LRL117	26.4 °F	27.0 °F	35.6 °F	49.3 °F	52.7 °F	64.4 °F	66.31 °F	68.3 °F	59.1 °F	45.4 °F	35.7 °F	30.0 °F	46.7 °F
		-3.1 °C	-2.8 °C	2.0 °C	9.6 °C	11.5 °C	18.0 °C	19.1 °C	20.2 °C	15.0 °C	7.4 °C	2.0 °C	-1.1 °C	8.2 °C

a = 1 day missing b = 2 days missing c = 3 days missing d = 4 days missing
 Monthly statistics not reported if more than 4 days are missing.

Table 5. Using aggregated data from more than a dozen COOP stations in proximity (within 100 km of the parks) known as PA Climate Division 8, the values indicate a somewhat wet winter followed by an average, relatively wet spring, a dry and cool summer and a cool, moist autumn.

Climate Division Rankings South Central Mountains	Jan-Feb-Mar WINTER	Apr-May-Jun SPRING	Jul-Aug-Sep SUMMER	Oct-Nov-Dec AUTUMN
Temperature-2008	62	58	83	85
Precipitation-2008	26	41	73	32
	1 = Warmest or Wettest		114 = Coldest or Driest	

Table 6. Temperature indicators of the climate near ALPO-JOFL parks using a COOP site at Ebensburg and a FAA site at Johnstown and comparing their 2008 data with a long-standing site at Pittsburgh, Pennsylvania. While the elevation does vary, the trend in 2008 showed near to slightly above average number of cold winter days, but a notable increase in the frequency of sub-freezing nights. The summer of 2008 brought fewer than average number of hot days and the length of the growing season was shorter than the 30-year average for Pittsburgh.

2008 statistics compared with 30-year means	Ebensburg, PA (EBNP1) 2008	Johnstown, PA (KJST) 2008	Pittsburgh, PA (KPIT) 1971–2000
Average Annual Maximum Temperature	58.6°F (14.8°C)	55.4°F (13.0°C)	60.4°F (15.8°C)
Average Annual Minimum Temperature	36.7°F (2.6°C)	39.9°F (4.4°C)	41.5°F (5.3°C)
Cold Days (number of days $T_{max} \leq 32^{\circ}\text{F}/0^{\circ}\text{C}$)	41	50	39.1
Sub-freezing Nights (number of days with $T_{min} \leq 32^{\circ}\text{F}/0^{\circ}\text{C}$)	147	134	123.9
Winter Minimums (Lowest Temp)	-5.0°F (-20.6°C)	-2.2°F (-19.0°C)	-22°F (-30.0°C)
Cold Winter Nights (number of days with $T_{min} \leq 0^{\circ}\text{F}/-17.8^{\circ}\text{C}$)	5	2	3.5
Hot Days (number of days $T_{max} \geq 90^{\circ}\text{F}/32^{\circ}\text{C}$)	0	0	7.4
Winter Minimums (Lowest Temp)	-5.0°F (-20.6°C)	-2.2°F (-19.0°C)	-22°F (-30.0°C)
Growing Season Length: Days between last spring $32^{\circ}\text{F}/0^{\circ}\text{C}$ and first fall $32^{\circ}\text{F}/0^{\circ}\text{C}$	137	159	160-180

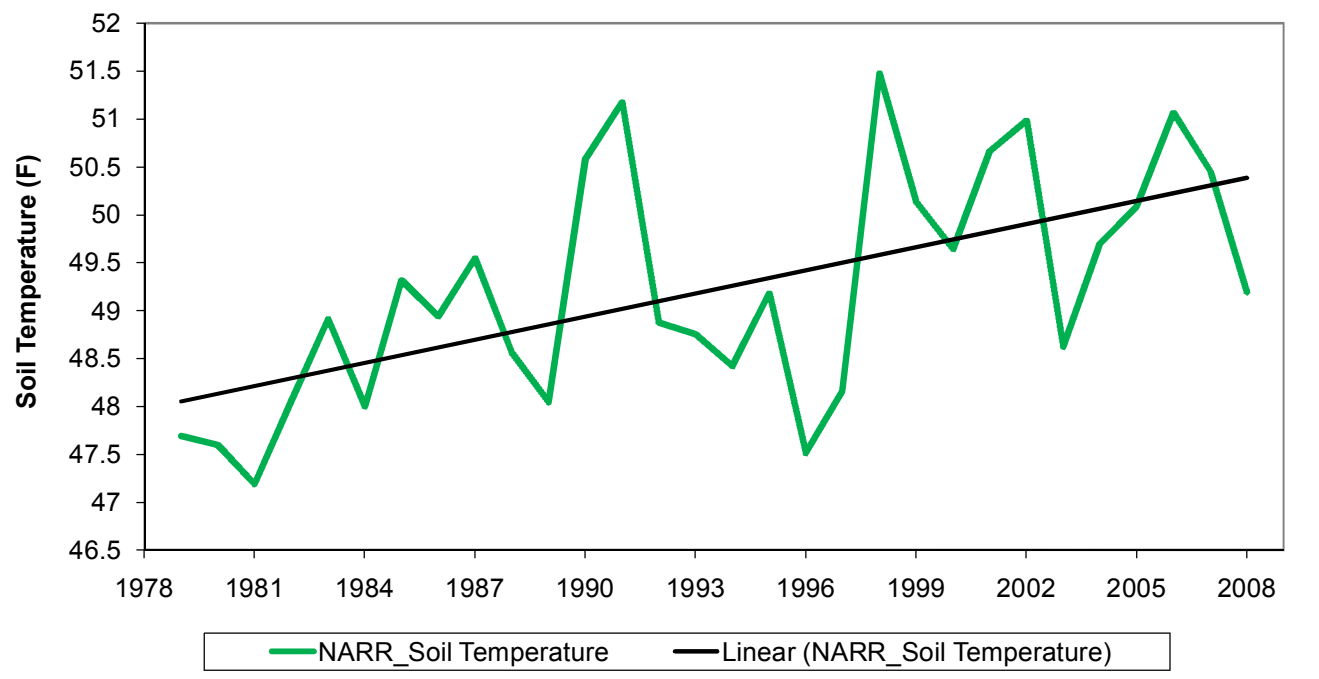


Figure 4. Annual soil temperature trends for ALPO-JOFL as seen from the North American Regional Reanalysis data set. The black line is the soil temperature trend for a 32-km square box within ALPO as derived from the North American Regional Reanalysis (NARR). The steady rise is consistent with the warming trend noted in the atmospheric during the past 30 years.

Growing Degree Days

The derived quantity, growing degree days – base 55°F (12.8°C), is shown for its accumulation and long-term trend during several important intervals of the annual growing season. The accumulation of growing degree days is directly related to the phenological cycle of the flora and fauna and its related pests and diseases. Trends in the growing degree days can signal changes in the exposure of the region's fauna to native and invasive pests. For the Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial, a small increase is noted in the early spring (Figure 5), but the remainder of the growing season shows no change (Figures 6 and 7) .

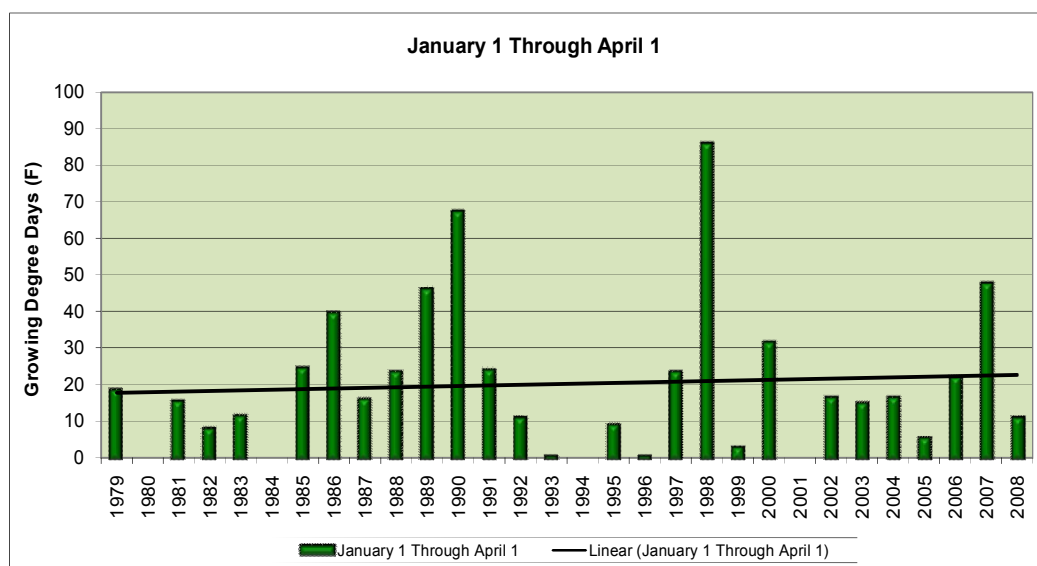


Figure 5: The accumulation of growing degree days for the ALPO/JOFL cooperative reporting stations based on a 90 day period from January 1 to April 1 each year. There is a small increase showing a slightly earlier start to the growing season.

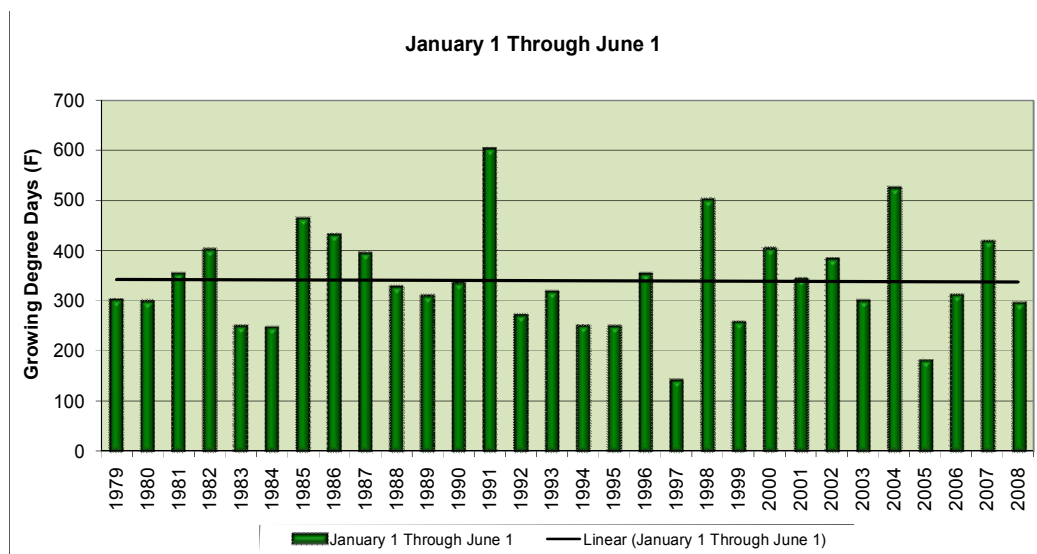


Figure 6: The accumulation of growing degree days for the ALPO/JOFL cooperative reporting stations based on a 150 day period from January 1 to June 1 each year. There is virtually no change during the last 30 years.

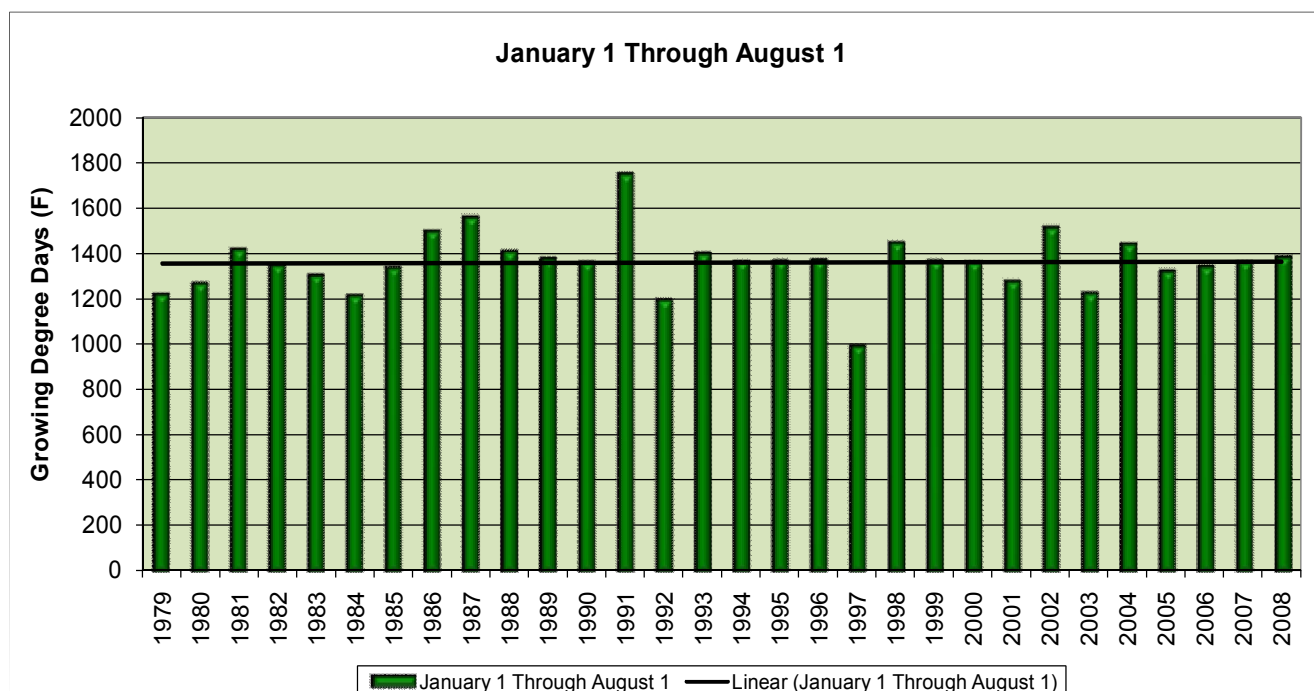


Figure 7: The accumulation of growing degree days for the ALPO/JOFL cooperative reporting stations based on the majority of the growing season (215 days). There has been no change during this period.

Calendar Year 2008 Precipitation Summary

Precipitation throughout 2008 was generally at or above average around the Johnstown Flood National Memorial and Allegheny Portage Railroad National Historic Site. The consistently positive precipitation anomalies allowed the year to rank as the 29th wettest in the South Central Mountain Climate Division (8) of Pennsylvania since records began in 1895.

However, the beginning of year featured below normal precipitation with January ranking as the 24th driest and the lowest amount since 2002. With a total of 1.9 inches (49 mm) for the month, only 50 percent of normal precipitation fell in Johnstown during January (Tables 7 and 8). The deficit to start the year was quickly erased in February when 3.9 inches (99 mm) of precipitation fell in the climate division. This was the wettest 2nd month of the year since 1998 and 18th wettest on record. March continued the above average trend with the wettest 3rd month since 1994. The positive anomalies were aided by one of the wettest days of the year on March 5th when 1.6 inches (40 mm) fell (Table 9). Overall, the winter was the 26th wettest on record with above normal snowfall too (Table 5). 74 inches (188 cm) fell in the region while the average is closer to 60 inches (152 cm) (Table 10) (Changnon et al, 2008).

Spring began with below normal precipitation. 3.1 inches (77 mm) fell in April in Ebensburg, PA which was 1.3 inches (33 mm) below normal (Tables 7 and 8). May of 2008 was the 20th wettest on record and the wettest since 2003. In June, about 3.7 inches (94 mm) of rain fell in region and precipitation tallied below average for the month.

The summer of 2008 was the driest season of the year and ranked the 41st driest summer (Table 5). Both July and August saw negative precipitation anomalies with 84 and 58 percent of normal respectively in Dunlo, PA (Table 8). August was the driest since 2002 and ranked the 38th driest on record. The below average precipitation was accompanied by the longest dry spell of the year which occurred from August 17th – 27th. Positive anomalies returned in September despite a dry spell from the 15th-25th (Table 10).

Precipitation anomalies in the fall varied drastically. October and November were both well below normal, ranking 35th and 38th driest, respectively. They were also the driest such months since 2001. Despite the dry weather in the first two months of fall, the season concluded as the 32nd wettest (Table 5). This was due to record setting precipitation in December. Two of the wettest days of the year occurred during this month with 1.7 inches (42 mm) on the 20th and 1.4 inches (35 mm) on Christmas day (Table 10). The month ranked as the wettest December of all time and almost twice as much of the normal precipitation fell during this month (7.8 inches; 166 mm) than October and November combined in Ebensburg, PA (Table 7). As a whole, the year 2008 was the wettest since 2004 and similar to 2007. Despite near to above normal precipitation in 2008, annual soil moisture trends have been on the decline over the past 30 years (Figure 9) in large part due to rising temperatures causing more evaporation.

Allegheny Portage Railroad NHS and Johnstown Flood NM
Percent of Average Monthly Precipitation
2008 vs. 1971–2000

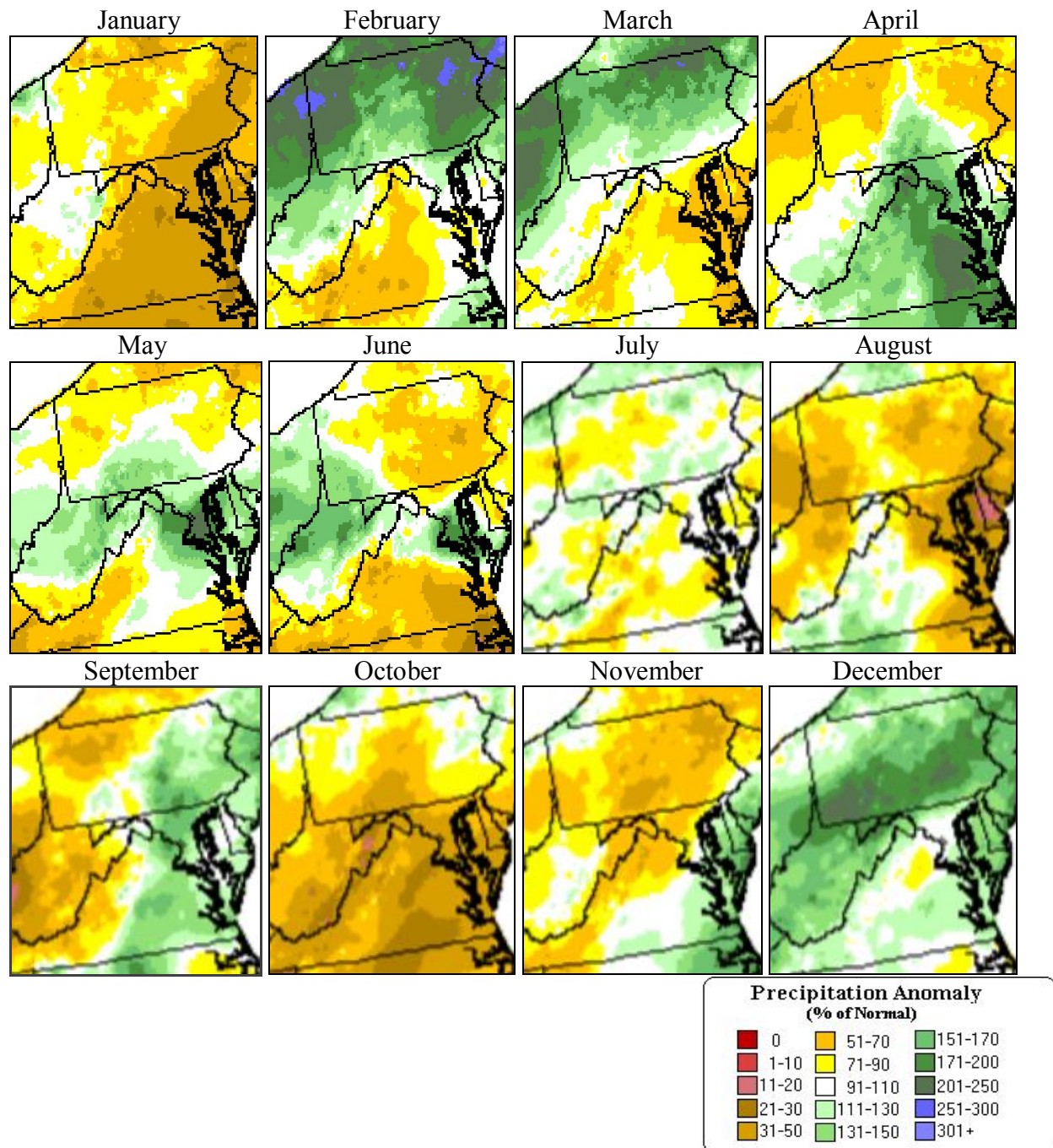


Figure 8. Maps showing percent of average precipitation for each month in the calendar year 2008 as compared with the normal based on the period 1971–2000. Departure values are reported in percent of normal. Maps were created using estimates from the Parameter-elevation Regressions on Independent Slopes Model (PRISM). PRISM uses an interpolation scheme for precipitation between actual observations and corrects these estimates for changes in topography across the region (Daly et al, 1994). More information can be found at: <http://www.prism.oregonstate.edu/>.

Table 7. Summary of 2008 monthly total precipitation (in/mm) for reporting sites around Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial.

Station Location	ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Dunlo, PA	DUNP1	1.5 in 37 mm	7.9 in 201 mm	5.9 in 150 mm	3.4 in 85 mm	3.0 in 76 mm	2.9 in 73 mm	4.7 in 120 mm	1.6 in 40 mm	5.7 in 145 mm	5.0 in 127 mm	2.3 in 57 mm	6.8 in 173 mm	50.6 in 1285 mm
Ebensburg, PA	EBNP1	3.0 in 65 mm	4.4 in 93 mm	5.8 in 103 mm	3.1 in 77 mm	6.1 in 162 mm	3.9 in 118 mm	2.6 in 106 mm	3.0 in 59 mm	4.1 in 140 mm	2.9 in 48 mm	2.8 in 63 mm	7.8 in 166 mm	49.5 in 1200 mm
Johnstown, PA	KJST	1.9 in 49 mm	3.0 in 77 mm	3.4 in 86 mm	2.54 in 65 mm	6.5 in 165 mm	4.4 in 111 mm	3.9 in 100 mm	2.3 in 59 mm	5.7 in 146 mm	1.5 in 37 mm	1.9 in 48 mm	6.5 in 164 mm	43.6 in 1106 mm

Table 8. Summary of 2008 percent of normal precipitation based on 30-year normal (1971–2000) for reporting sites around Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial.

Station Location	ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Dunlo, PA	DUNP1	66	109	111	69	134	104	84	58	127	56	60	181	97
Ebensburg, PA	EBNP1	77	130	131	71	128	88	53	74	94	85	68	216	101
Johnstown, PA	KJST	50	85	122	66	150	90	77	56	139	55	52	202	95

Table 9. A comparison of wettest single calendar days during 2008 with the longest periods with a trace or less of rainfall during the same year in Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial. (Data from the COOP station at Ebensburg, PA).

Wettest Days in 2008	Dry Spells in 2008
Dec. 20: 1.7 in (42 mm)	Aug. 17–27
Mar. 5: 1.6 in (40 mm)	Sept. 15–25
Sept. 13: 1.5 in (39 mm)	Oct. 31–Nov. 7
Dec. 25: 1.4 in (35 mm)	Oct. 10–15

Table 10. Precipitation indicators of the climate around the Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial parks using a COOP site at Ebensburg and a FAA site at Johnstown and comparing their 2008 data with a long-standing site at Pittsburgh, Pennsylvania. While elevation does vary, trends in 2008 showed an increase in annual rainfall and a near average number of excessively wet days.

2008 Statistics compared with 30-year means	Ebensburg, PA (EBNP1) 2008	Johnstown, PA (KJST) 2008	Pittsburgh, PA (KPIT) 1971–2000
Annual Precipitation in inches (millimeters)	49.5 (1257)	43.6 (1107)	37.9 (963)
Autumn (Oct, Nov, Dec) Precipitation in inches (millimeters)	13.5 (343)	9.8 (249)	-
Annual Snowfall in inches (centimeters)	87 (221)	74 (188)	41 (104) (KJST ~60) (152)
Micro-drought (number of strings of 7+ days without rain)	3	3	-
Number of days ≥ 1.0 in (2.5 cm) rain	5	7	6
Heavy Rain (number of days ≥ 2.00 in (5.1 cm) rain)	0	1	-
Number of days with ≥ 0.1 in (0.3 cm) snow	46	46	-
Number of days with ≥ 1.0 in (2.5 cm) snow	31	30	12

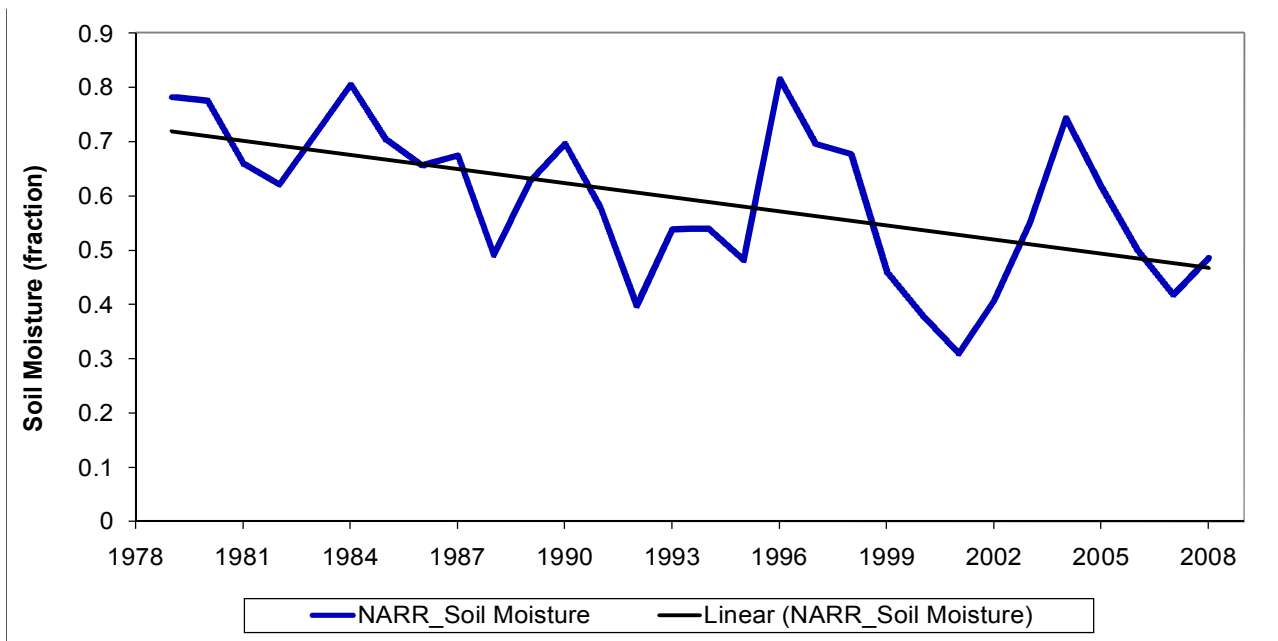


Figure 9. Annual soil moisture trends for ALPO/JOFL as seen from the North American Regional Reanalysis data set. The black line is the soil moisture trend for a 32-km square box within ALPO as derived from the North American Regional Reanalysis (NARR). There has been a steady decline in the soil moisture content during the last 30 years.

Stream Flow for 2008

The USGS maintains river level and flow monitoring gauges along the Conemaugh River. Of course, there is a response time between rainfall, snow-melt and changes in the river conditions. There is also seasonality to the river flow with peak flows typically occurring in the spring and minimum flow being measured in the autumn (Groisman et al, 2000). However, increases in precipitation amount and intensity during the past several decades have overridden some of this seasonality. Two gauges were selected to profile river level and flow during the calendar year 2008 and these are displayed in Figures 10–11.

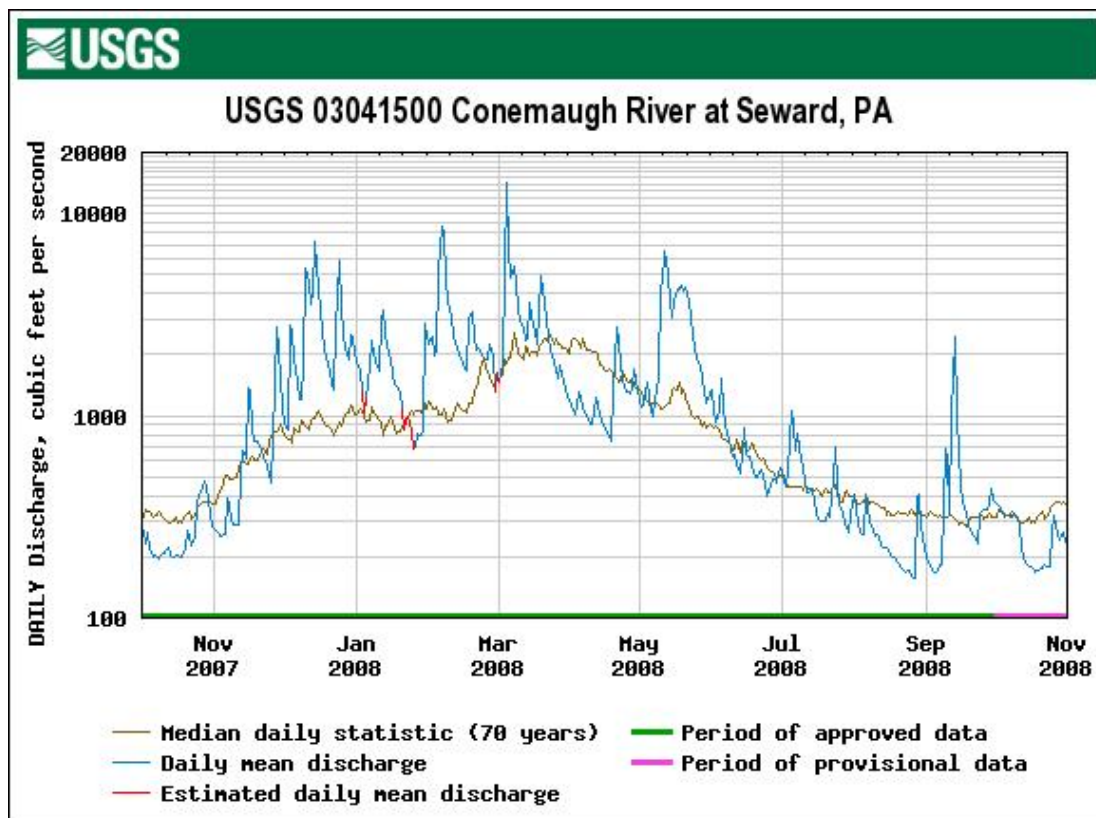


Figure 10: The Conemaugh River flows near the Johnstown Flood National Memorial. Below normal discharge can be seen beginning in June and extending into the autumn.

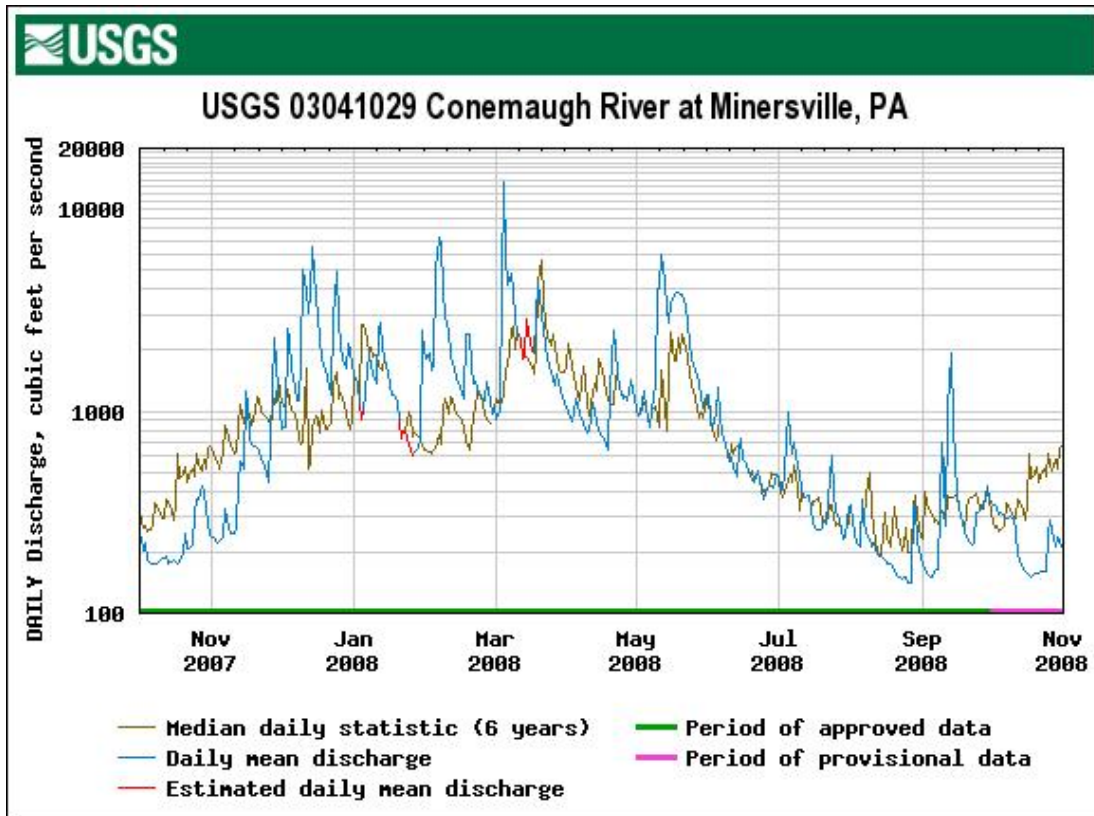


Figure 11. The flow of the Conemaugh River near the Johnstown Flood National Memorial. The effects of a wet winter and then a dry summer are notable as the blue line is above the brown line until May and then only above in early September.

Drought Status

The U.S. Drought Monitor (USDM; <http://www.drought.unl.edu/dm/monitor.html>) tracks drought conditions across the nation on a weekly basis, and it incorporates data and expert input from a wide variety of state and federal agencies (NIDIS, 2008). The USDM is designed to represent a “broad brush,” regional perspective on drought, and therefore provides an ideal tool for tracking generalized drought conditions across the Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial parks and surrounding areas (Figures 12–14). According to the USDM, the summer and autumn was drier than normal. Despite this dry periods, the region returned to normally moist ($> +1$) in December. When compared with the past few years, 2008 was noticeably moister than 2007 and almost opposite to 2006. Since the PDSI responds to long-term effects, including evaporation, there is usually a lag between both long dry spells and episodes of heavy rain and changes in the index value.

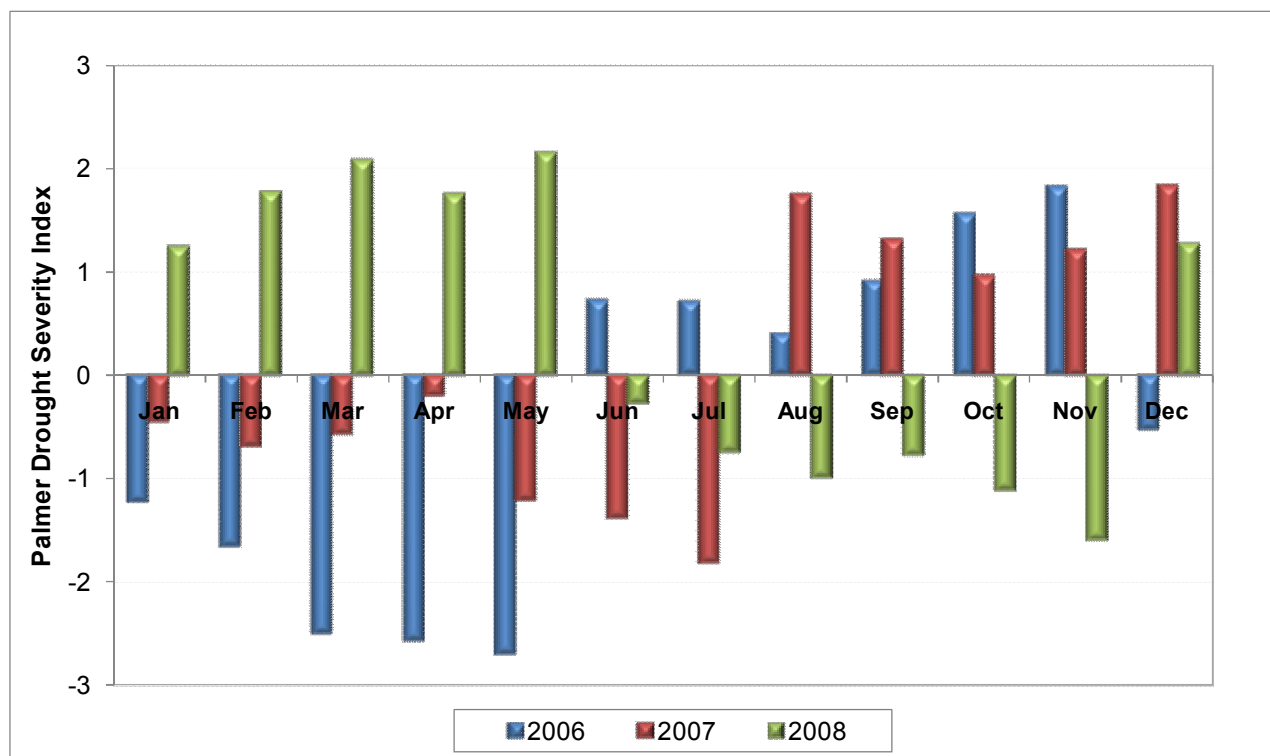


Figure 12. A comparison of the Palmer Drought Severity Index (PDSI) for the Pennsylvania Climate Division 8, which encompasses most of ALPO and JOFL. The PDSI during 2008 was above normal indicating moist conditions for the first half of the year, but drier conditions returned during the summer and autumn months (the long-term average value is zero).

Drought Severity in Pennsylvania during 2008

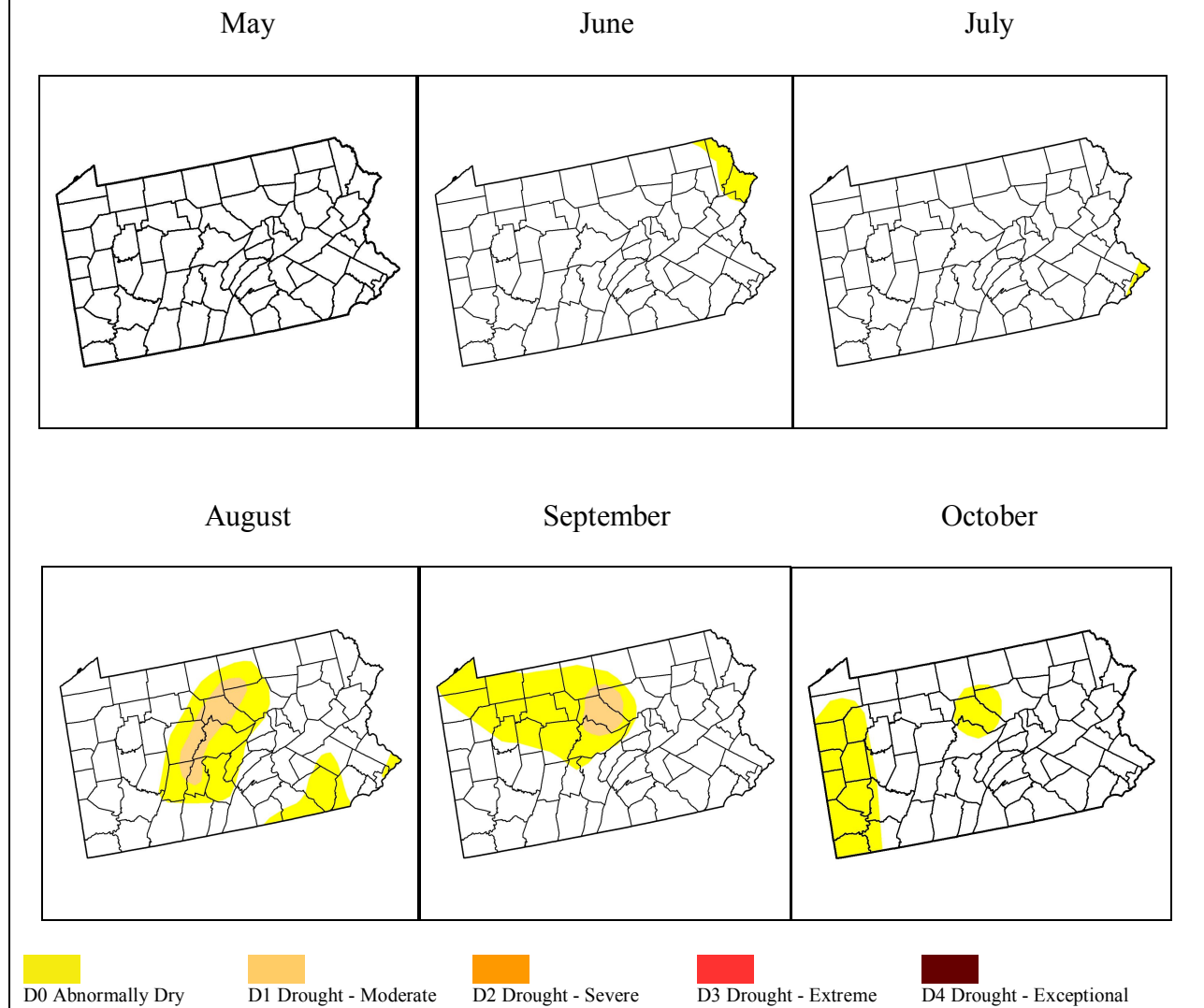


Figure 13. The mid-month values of the PDSI for Pennsylvania showing that dry conditions rarely encroached on the Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial region.

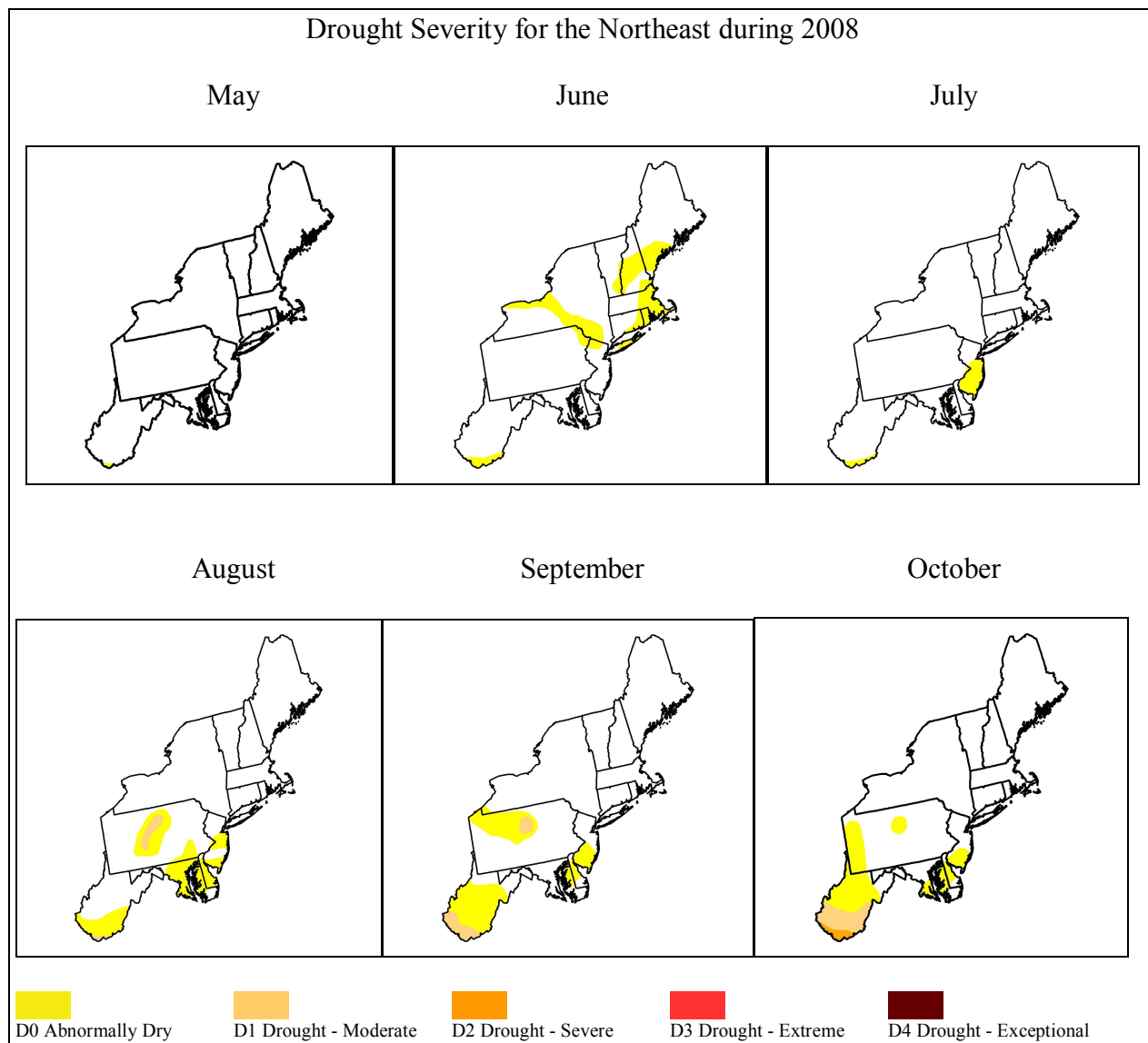


Figure 14. The mid-month values of the PDSI for the Northeast during the 2008 warm season. Southern New Jersey was the most consistently dry region.

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Appendix.

The following tables are a tally of all reports of severe weather during 2008 in the counties that encompass Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial. These storm events were provided by the National Climatic Data Center (NCDC). NCDC receives this storm data from the National Weather Service, who acquires their information from a variety of sources. These sources include but are not limited to: county, state, and federal emergency management officials, local law enforcement officials, skywarn spotters, NWS damage surveys, newspaper clipping services, the insurance industry, and the general public. This Storm Data is an official publication of the National Oceanic and Atmospheric Administration (NOAA) which documents the occurrence of storms and other significant weather phenomena having sufficient intensity to cause loss of life, injuries, significant property damage, and/or disruption to commerce. Each table contains the location, date, time, description of the severe event, its magnitude, and number of deaths, injuries, and property/crop damage associated with the event. The property and crop damage should be considered as a broad estimate.

Blair County

Location or County	Date	Time	Type	Mag	Dth	Inj	PrD	CrD
PAZ004>006 - 010>012 - 017>019 - 024>028 - 033>035 - 037 - 041>042 - 045>046 - 049>053 - 058	2/1/2008	3:00 AM	Winter Storm	N/A	0	0	0K	0K
PAZ004 - 010>012 - 017>018 - 024>025 - 033>034 - 037 - 041	2/10/2008	18:00 PM	Extreme Cold/wind Chill	N/A	0	0	0K	0K
PAZ025	5/11/2008	16:30 PM	High Wind	50 kts.	0	0	0K	0K
Ironville	6/16/2008	15:57 PM	Thunderstorm Wind	50 kts.	0	0	0K	0K
Newry Arpt	6/26/2008	20:50 PM	Thunderstorm Wind	50 kts.	0	0	0K	0K
Mill Run	6/26/2008	20:55 PM	Thunderstorm Wind	50 kts.	0	0	0K	0K
Mill Run	7/20/2008	15:23 PM	Thunderstorm Wind	50 kts.	0	0	0K	0K
Tyrone	7/24/2008	13:45 PM	Thunderstorm Wind	50 kts.	0	0	0K	0K
Tyrone	7/24/2008	13:48 PM	Hail	0.88 in.	0	0	0K	0K
Altoona	7/24/2008	14:03 PM	Thunderstorm Wind	50 kts.	0	0	0K	0K
Williamsburg	7/24/2008	14:10 PM	Thunderstorm Wind	50 kts.	0	0	0K	0K
PAZ019 - 025 - 045	9/14/2008	21:45 PM	High Wind	50 kts.	0	0	0K	0K
PAZ004>006 - 010>012 - 018>019 - 024>025 - 033>034 - 037 - 041>042 - 045>046 - 058	12/21/2008	23:00 PM	Extreme Cold/wind Chill	N/A	0	0	0K	0K
					Totals:	0	0	0

Mag:	Magnitude
Dth:	Deaths
Inj:	Injuries
PrD:	Property Damage
CrD:	Crop Damage

Cambria County

Location or County	Date	Time	Type	Mag	Dth	Inj	PrD	CrD
PAZ024	1/9/2008	4:00 AM	Strong Wind	44 kts.	0	0	10K	0K
PAZ005 - 010>011 - 024 - 033	1/19/2008	4:00 AM	Extreme Cold/wind Chill	N/A	0	0	0K	0K
PAZ024	1/30/2008	6:00 AM	High Wind	50 kts.	0	0	0K	0K
PAZ004>006 - 010>012 - 017>019 - 024>028 - 033>035 - 037 - 041>042 - 045>046 - 049>053 - 058	2/1/2008	3:00 AM	Winter Storm	N/A	0	0	0K	0K
PAZ004 - 010>012 - 017>018 - 024>025 - 033>034 - 037 - 041	2/10/2008	18:00 PM	Extreme Cold/wind Chill	N/A	0	0	0K	0K
PAZ010 - 017 - 024 - 033	2/29/2008	13:00 PM	Heavy Snow	N/A	0	0	0K	0K
PAZ024	5/11/2008	13:30 PM	High Wind	50 kts.	0	0	0K	0K
Nanty Glo	6/22/2008	22:45 PM	Hail	1.00 in.	0	0	0K	0K
Johnstown	6/26/2008	20:20 PM	Thunderstorm Wind	61 kts.	0	4	1K	0K
Johnstown	6/26/2008	20:23 PM	Thunderstorm Wind	61 kts.	0	0	0K	0K
Barnesboro	7/20/2008	14:57 PM	Thunderstorm Wind	50 kts.	0	0	0K	0K
Glasgow	7/24/2008	13:17 PM	Hail	0.88 in.	0	0	0K	0K
PAZ006 - 010>012 - 017>018 - 024 - 037 - 041	9/14/2008	21:30 PM	High Wind	50 kts.	0	0	0K	0K
PAZ006 - 010>012 - 017>018 - 024 - 037 - 041	12/11/2008	7:00 AM	Winter Storm	N/A	0	0	0K	0K
PAZ004>006 - 010>012 - 018>019 - 024>025 - 033>034 - 037 - 041>042 - 045>046 - 058	12/21/2008	23:00 PM	Extreme Cold/wind Chill	N/A	0	0	0K	0K
				Totals:	0	4	11K	0

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS XXXXXX, February 2010

National Park Service
U.S. Department of the Interior



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